US009174250B2

(12) **United States Patent**
Lee et al.

(10) **Patent No.: US 9,174,250 B2**
(45) **Date of Patent: Nov. 3, 2015**

(54) **METHOD AND APPARATUS FOR CLEANING ORGANIC DEPOSITION MATERIALS**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 363 days.

(21) Appl. No.: **13/208,261**

(22) Filed: **Aug. 11, 2011**

(65) **Prior Publication Data**

US 2011/0293819 A1 Dec. 1, 2011

Related U.S. Application Data

(63) Continuation-in-part of application No. 12/795,896, filed on Jun. 8, 2010.

(30) **Foreign Application Priority Data**

Jun. 9, 2009 (KR) 10-2009-0051064
Feb. 10, 2010 (KR) 10-2010-0012406

(51) **Int. Cl.**
B05D 5/12 (2006.01)
B08B 7/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***B08B 7/0035*** (2013.01); ***B08B 7/0042*** (2013.01); ***C23C 14/042*** (2013.01); ***C23C 14/564*** (2013.01); ***H01L 51/0025*** (2013.01); *H01L 51/56* (2013.01)

(58) **Field of Classification Search**
USPC 427/58, 532; 118/50, 66, 715, 721; 313/504; 134/1.1, 1.2
See application file for complete search history.

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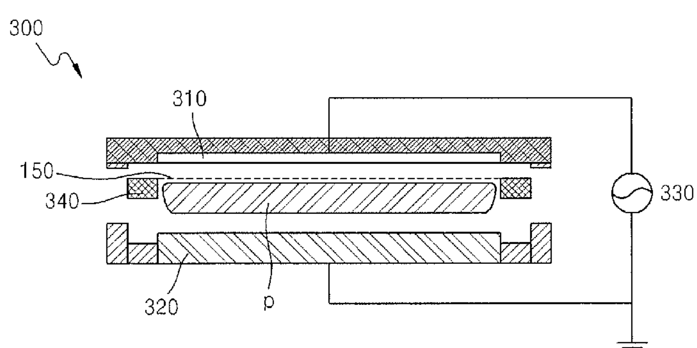
(74) *Attorney, Agent, or Firm* — Christie, Parker & Hale, LLP

(57) **ABSTRACT**

A method of cleaning off organic deposition material accumulated on a mask includes forming an organic deposition material pattern on a substrate using the mask, which includes a plurality of slots, in a deposition chamber including a deposition source; transporting the mask to a stock chamber that is maintained at a vacuum and adjacent to the deposition chamber; and partially cleaning off the organic deposition material accumulated along the boundaries of the slots of the mask in the stock chamber. A system to clean off an organic deposition material accumulated on a mask having a plurality of slots, includes a deposition chamber including a deposition source; and a stock chamber that is maintained at substantially the same vacuum as the deposition chamber and includes a cleaning device that cleans off the organic deposition material accumulated on the mask.

17 Claims, 15 Drawing Sheets



(51) **Int. Cl.**

C23C 14/04	(2006.01)
C23C 14/56	(2006.01)
H01L 51/00	(2006.01)
H01L 51/56	(2006.01)

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U.S. Appl. No. 12/795,896, filed Jun. 8, 2010, Lee, et al., Samsung Mobile Display Co., Ltd.

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FIG. 1

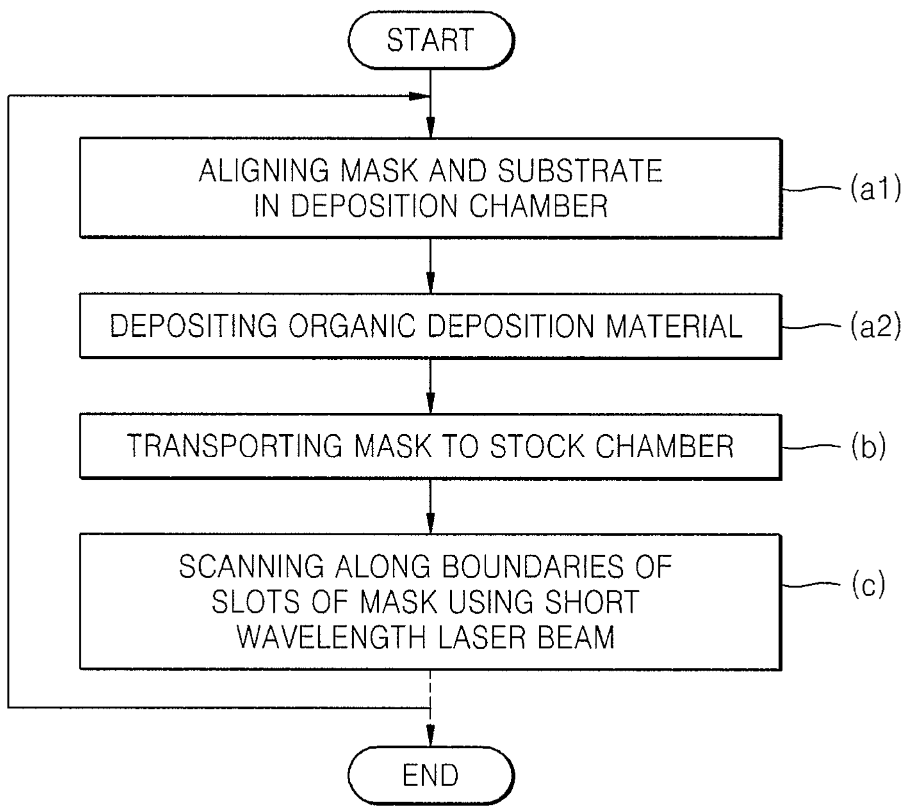

START
ALIGNING MASK AND SUBSTRATE IN DEPOSITION CHAMBER
(a1)
DEPOSITING ORGANIC DEPOSITION MATERIAL
(a2)
TRANSPORTING MASK TO STOCK CHAMBER
(b)
SCANNING ALONG BOUNDARIES OF SLOTS OF MASK USING SHORT WAVELENGTH LASER BEAM
(c)
END

FIG. 2

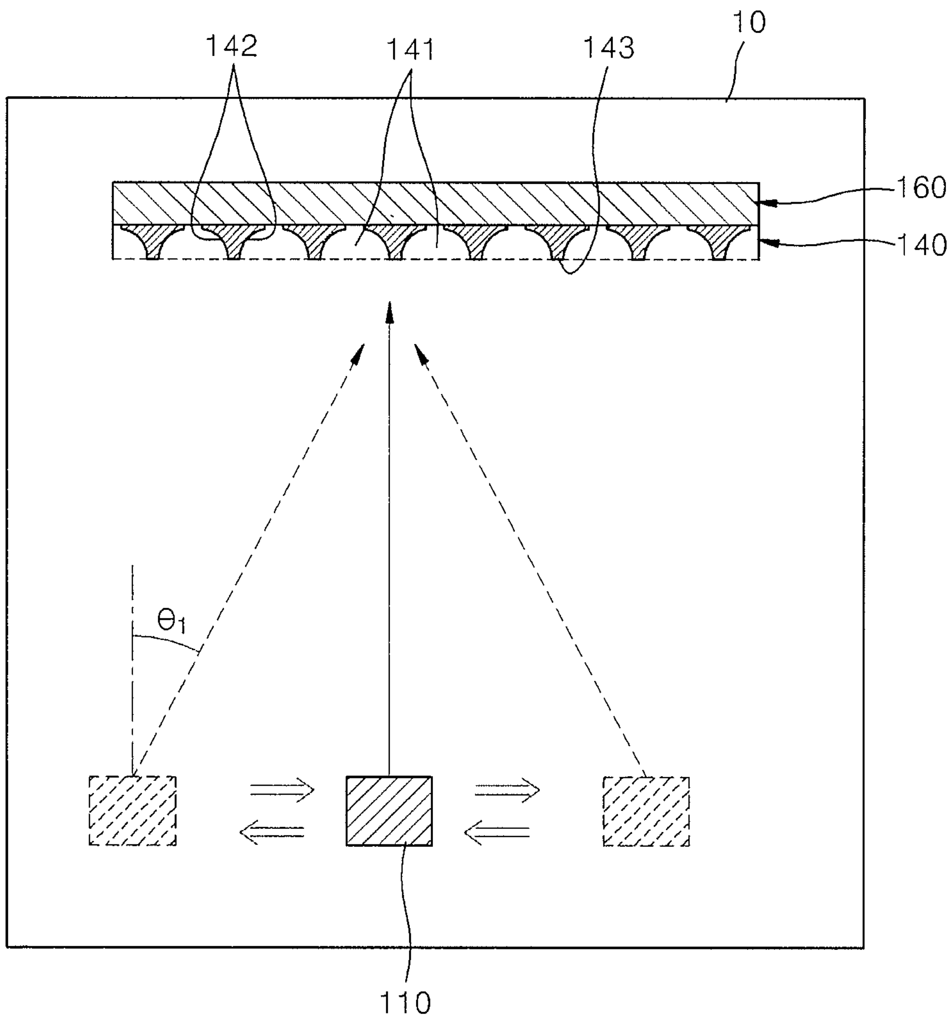


FIG. 3

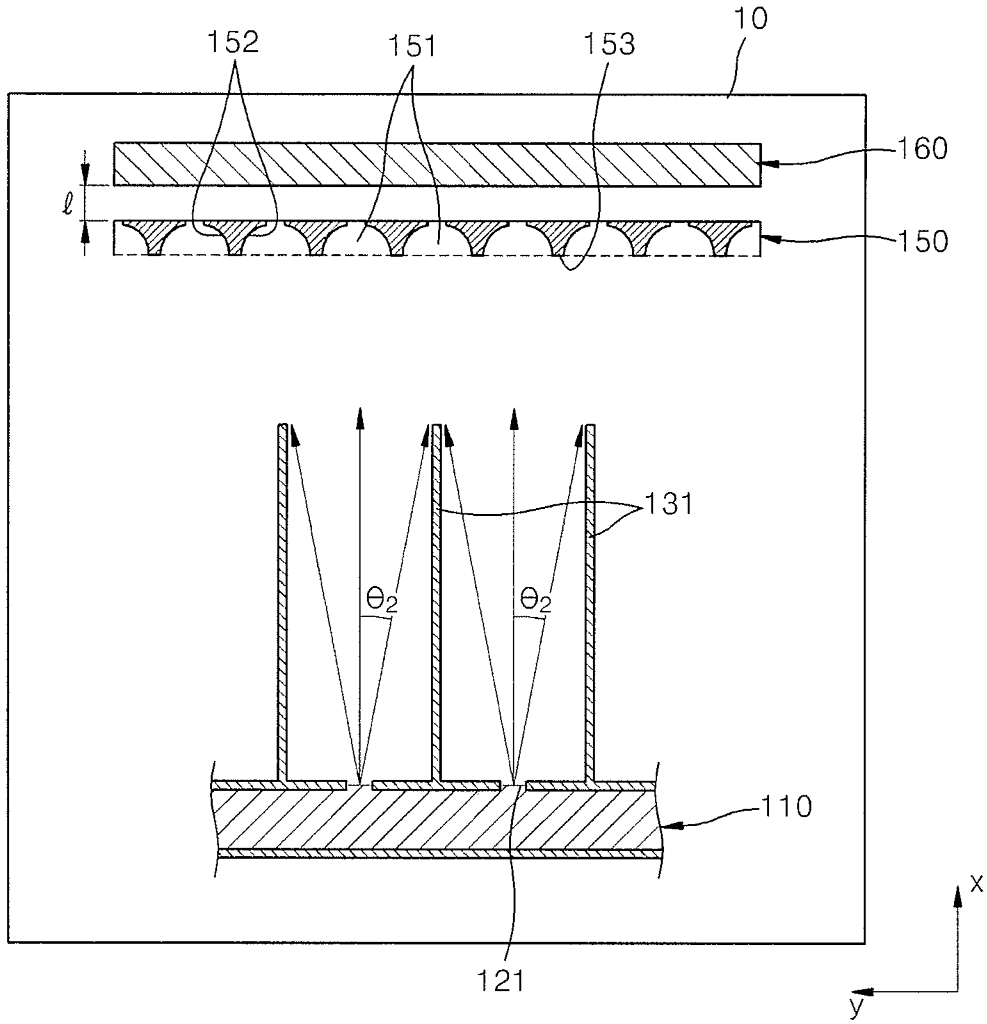


FIG. 4

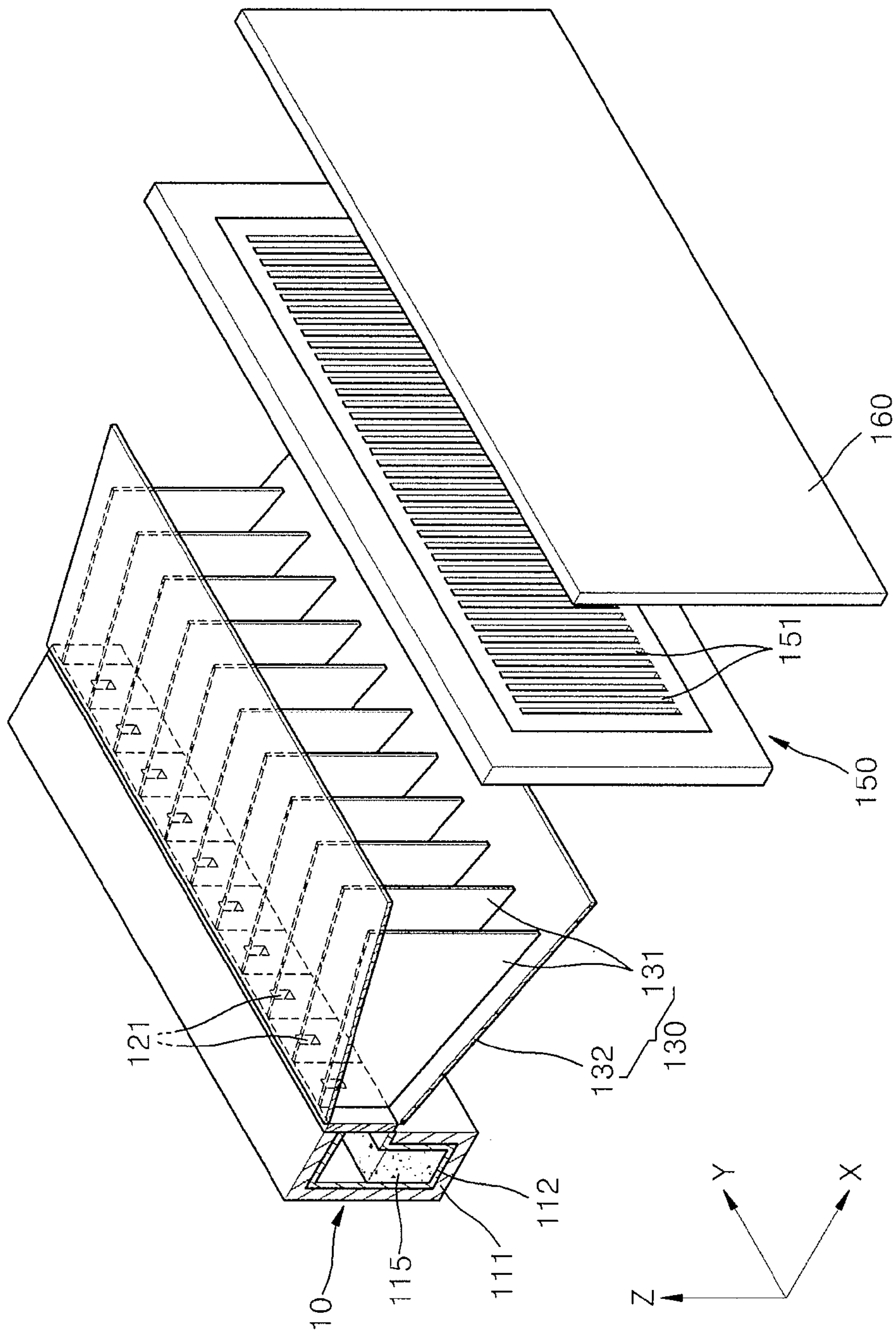


FIG. 5

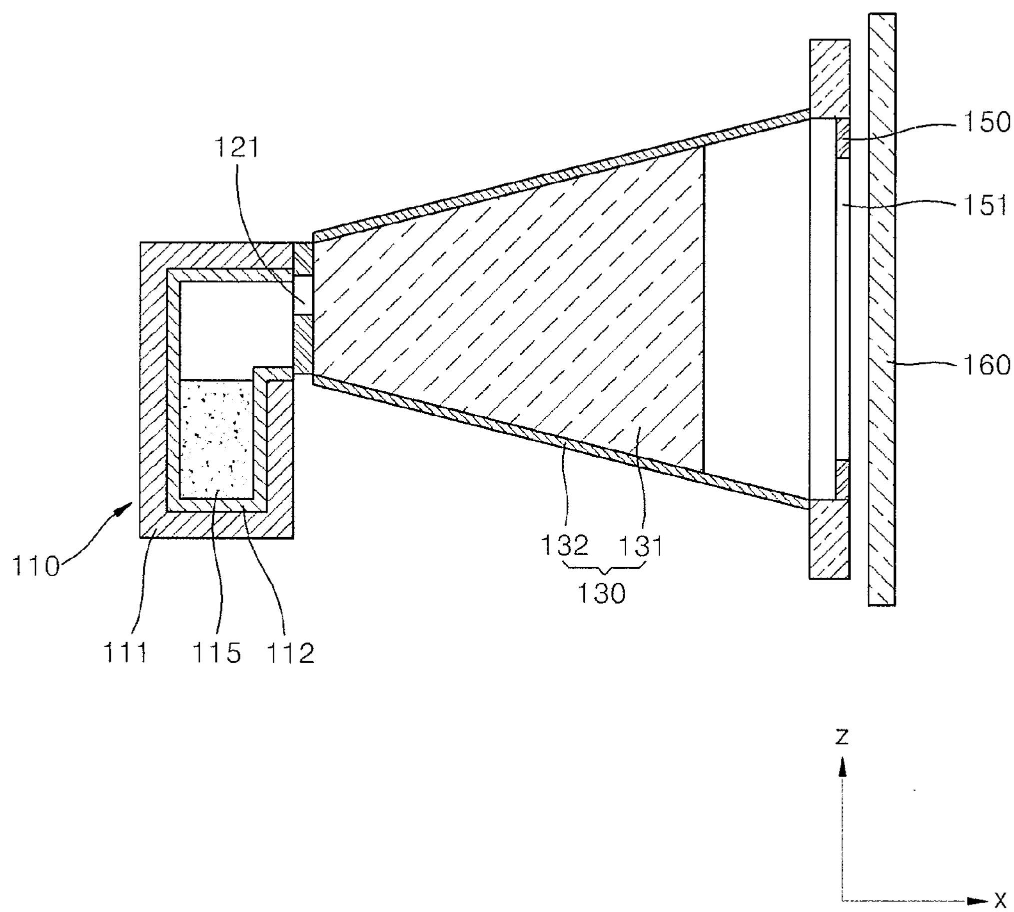


FIG. 6

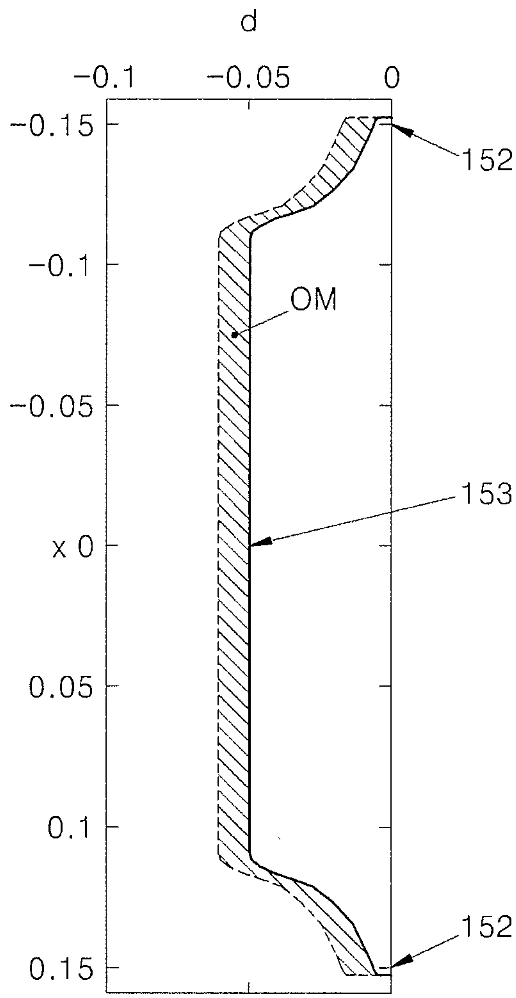


FIG. 7

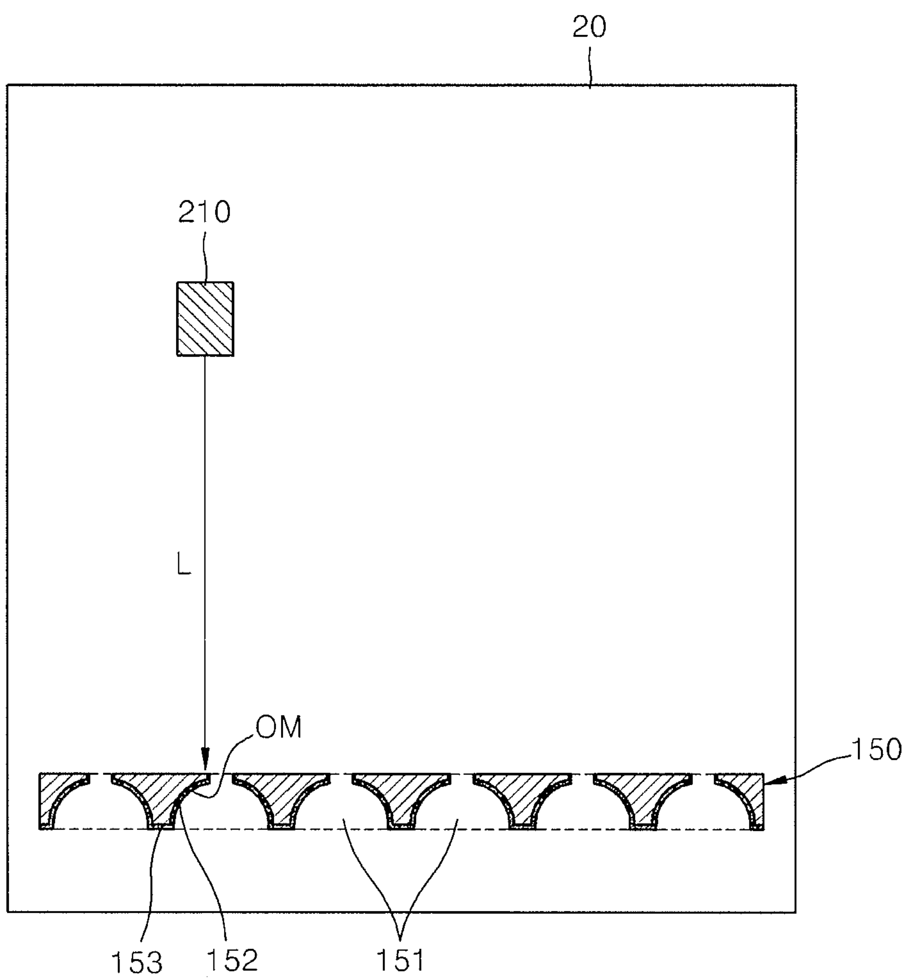


FIG. 8

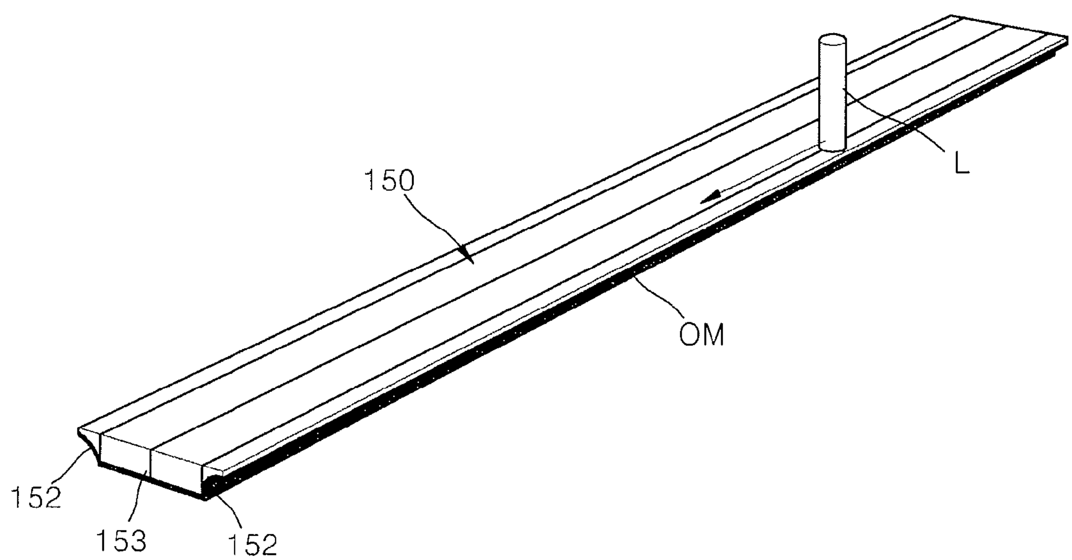


FIG. 9

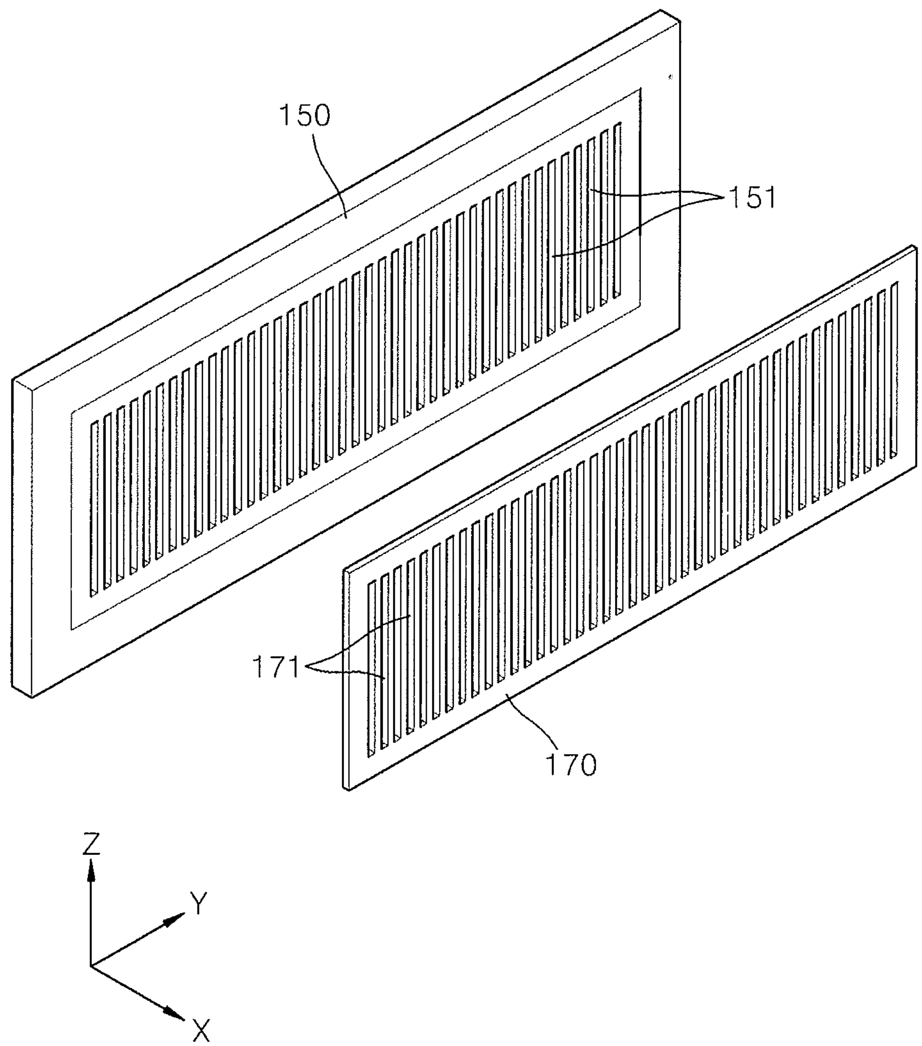


FIG. 10

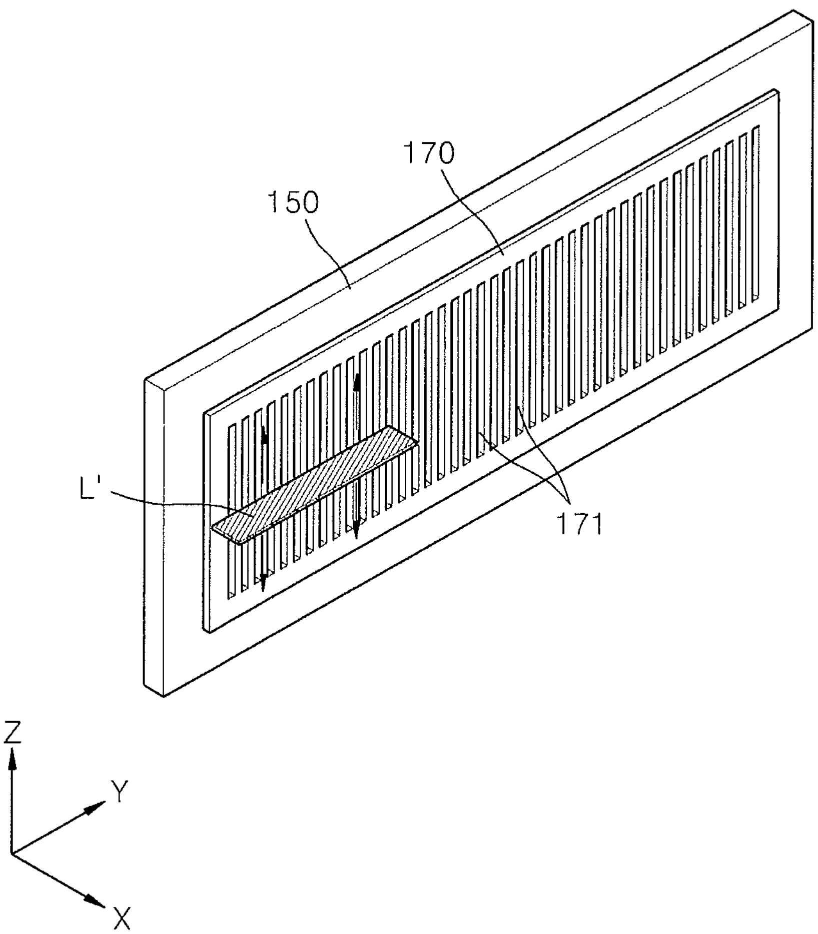


FIG. 11

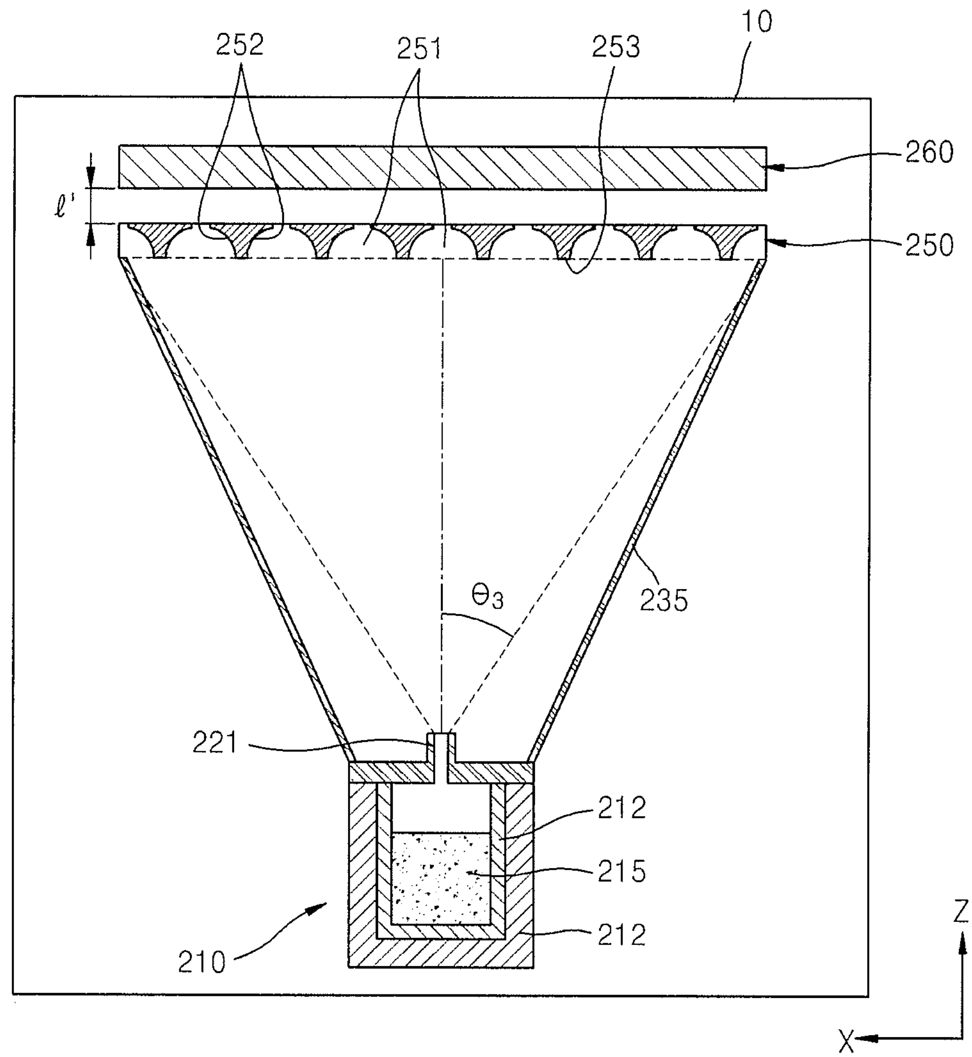


FIG. 12

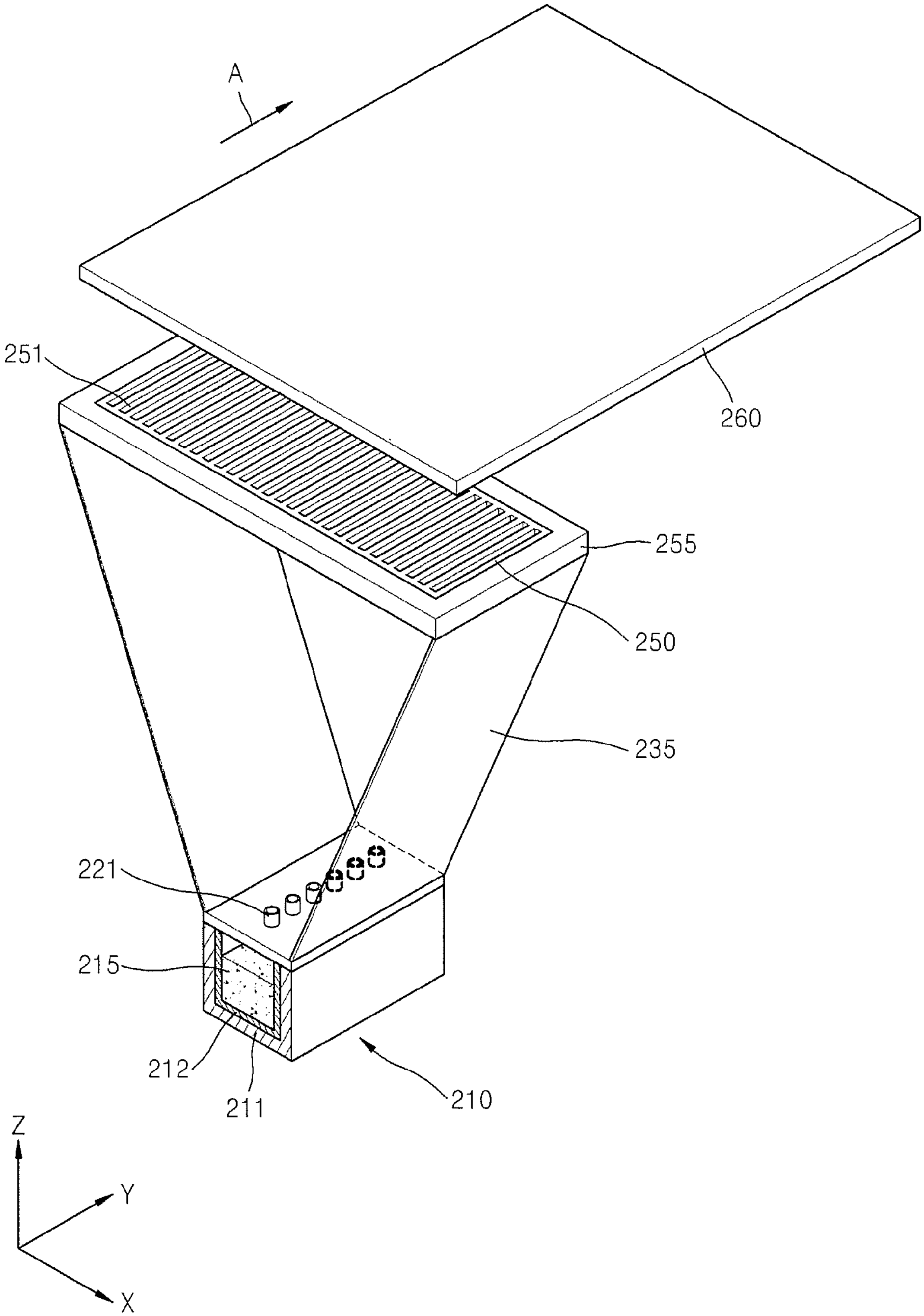


FIG. 13

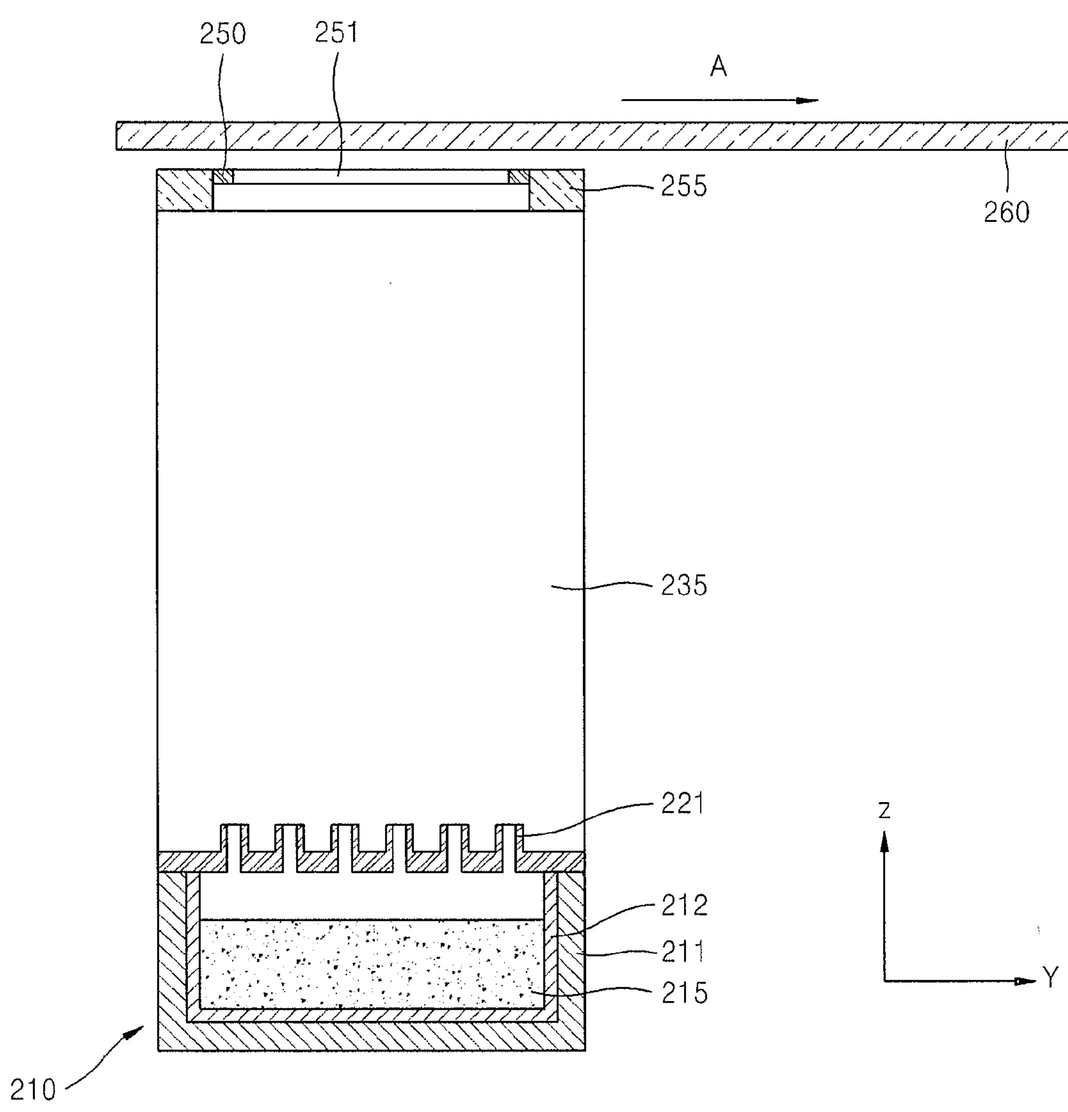


FIG. 14

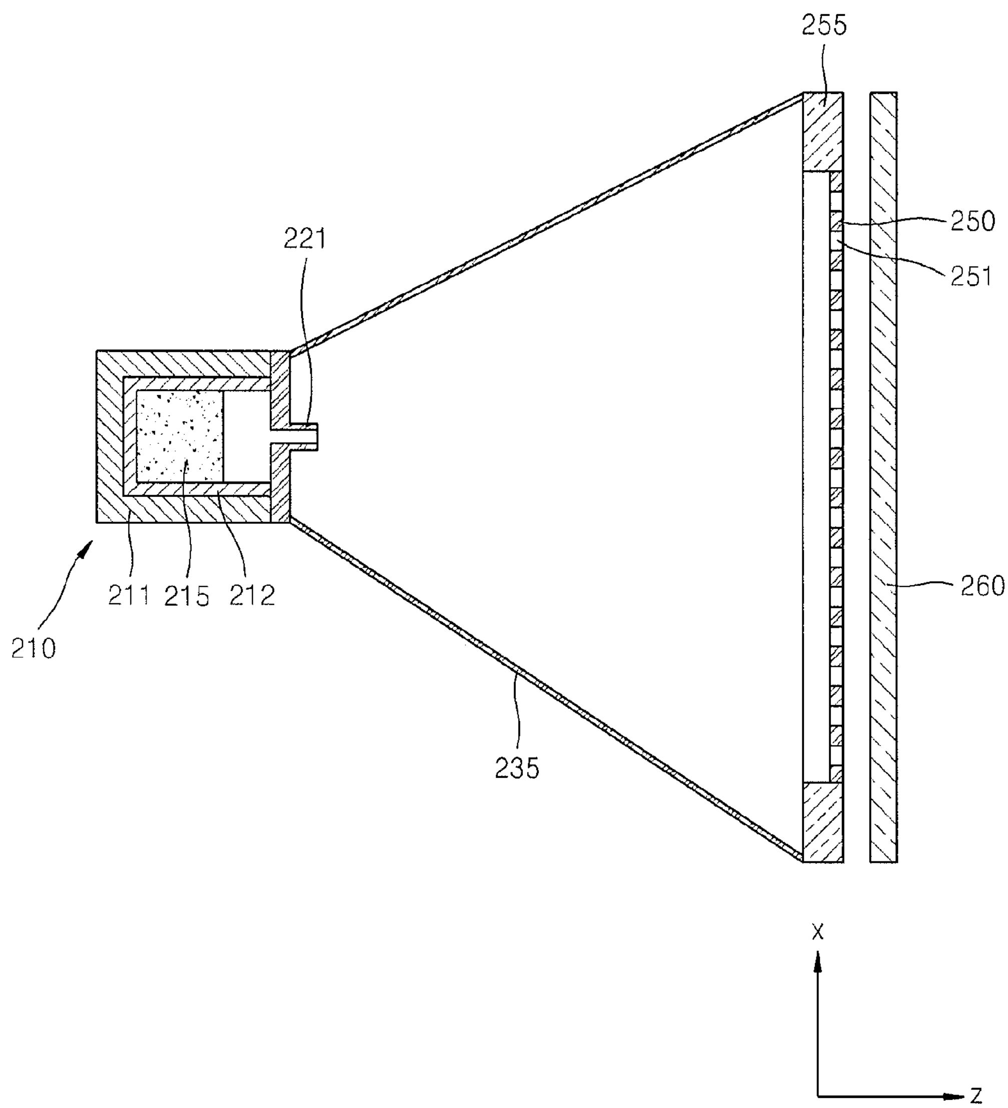
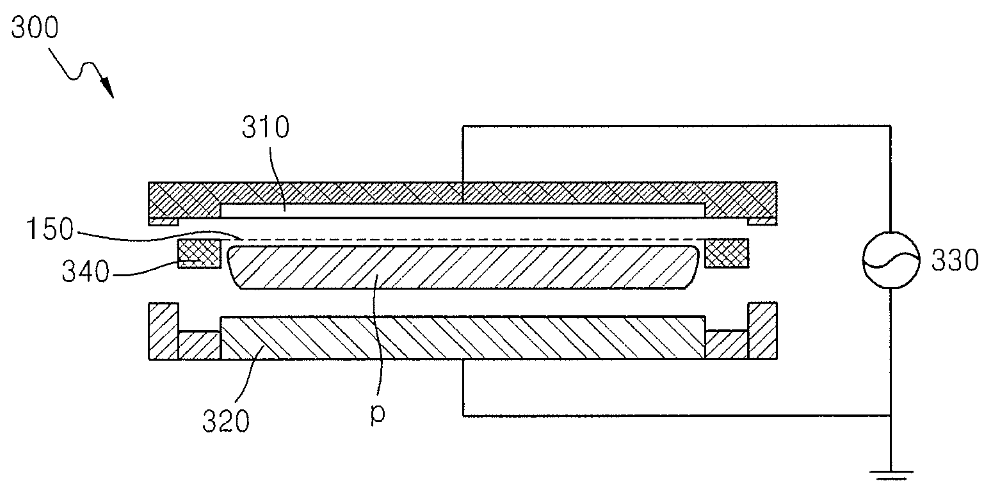


FIG. 15



METHOD AND APPARATUS FOR CLEANING ORGANIC DEPOSITION MATERIALS

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of U.S. patent application Ser. No. 12/795,896, filed Jun. 8, 2010, which claims priority to and the benefit of Korean Patent Application No. 10-2009-0051064, filed Jun. 9, 2009, and Korean Application No. 10-2010-0012406, filed Feb. 10, 2010, the entire contents of all of which are incorporated herein by reference.

BACKGROUND

1. Field

Aspects of the present invention relate to a method and system to clean organic deposition materials accumulated on a mask used in a process of depositing organic deposition materials.

2. Description of the Related Art

Organic light-emitting display devices have a larger viewing angle, better contrast characteristics, and a faster response rate than other display devices, and thus have drawn attention as a next-generation display device.

In general, an organic light-emitting display device has a stacked structure including an anode, a cathode, and an emission layer interposed between the anode and the cathode. The device may display images in color when holes and electrons, injected respectively from the anode and the cathode, are recombined in the emission layer such that light is emitted. To improve the light-emission efficiency of such a structure, intermediate layers, including an electron injection layer, an electron transport layer, a hole transport layer, a hole injection layer, etc., may be additionally interposed between the emission layer and each of the electrodes.

In this regard, an organic thin film such as an emission layer and an intermediate layer may be formed in a fine pattern by deposition. When an organic light-emitting display device is manufactured by using the deposition method, a fine metal mask (FMM) having the same pattern as a thin film to be formed is disposed to closely contact a substrate, and a thin film material is deposited over the FMM in order to form the thin film having the desired pattern.

Meanwhile, devices within a deposition chamber including a mask typically should be subjected to preventive maintenance (PM) according to a predetermined cycle count when the deposition process is repeatedly performed. In the process of manufacturing organic light-emitting display devices using an FMM, the FMM may be separated to be cleaned according to a predetermined PM cycle count (e.g., after every 80 depositions on the substrate).

SUMMARY

Aspects of the present invention provide a method and system to clean off organic deposition materials from a mask used in a deposition process to form organic deposition material patterns, whereby a cleaning cycle of the mask and a preventive maintenance (PM) cycle of the deposition process may be extended.

According to an aspect of the present invention, there is provided a method of cleaning off an organic deposition material accumulated on a mask used to form an organic deposition material pattern on a substrate, the method including: using the mask, having a plurality of slots in a deposition chamber including a deposition source, to form the organic deposition material pattern on the substrate; transporting the mask to a stock chamber that is maintained at a vacuum and adjacent to the deposition chamber; and cleaning off the organic deposition material accumulated on the mask in the stock chamber.

According to a non-limiting aspect, boundaries of the slots may be inclined.

According to a non-limiting aspect, the slots may be disposed to be substantially parallel to each other and extend in a predetermined direction.

According to a non-limiting aspect, the substrate on which the organic deposition material pattern is formed may include an organic light emitting device (OLED) panel substrate.

According to a non-limiting aspect, at least one organic deposition material selected from the group consisting of organic deposition materials used to form an emission layer, an electron injection layer, an electron transport layer, a hole injection layer, and a hole transport layer may be deposited on the OLED panel substrate.

According to a non-limiting aspect, the organic deposition material pattern may be formed by disposing the mask in close contact with the substrate, and depositing the organic deposition material on the substrate while the deposition source is moved relative to the mask.

According to a non-limiting aspect, the organic deposition material pattern may be formed by spacing the mask apart from the substrate by a predetermined distance, and wherein the organic deposition material is deposited on the substrate while the deposition source is fixed relative to the mask.

According to a non-limiting aspect, a plurality of first slits may be disposed along a first direction at one side of the deposition source; a plurality of barrier walls (that partition a space between the deposition source and the mask into a plurality of sub-deposition spaces) are disposed along the first direction; and a barrier wall assembly including a barrier wall frame (that surrounds the barrier walls) are disposed between the deposition source and the mask, wherein the barrier wall assembly and the mask are detachable.

According to a non-limiting aspect, the plurality of slots formed in the mask may provide a portion of the organic deposition material pattern to be formed on the substrate, and deposition of the organic deposition material on the substrate may be conducted by scanning the mask along a direction perpendicular to the first direction with respect to the substrate.

According to a non-limiting aspect, a plurality of second slits may be disposed along a first direction at one side of the deposition source, and a connection member (that guides the deposition material which is discharged from the deposition source to the substrate) may be disposed between the deposition source and the mask, wherein the connection member and the mask are detachable.

According to a non-limiting aspect, the plurality of slots formed in the mask may form a portion of the organic deposition material pattern to be formed on the substrate, and deposition of the organic deposition material on the substrate may be conducted by scanning the substrate along the first direction with respect to the mask.

According to a non-limiting aspect, the cleaning off of the organic deposition material may be performed using plasma.

According to a non-limiting aspect, the cleaning off of the organic deposition material may be performed by cleaning off the organic deposition material accumulated along the boundaries of the slots formed in the mask.

According to a non-limiting aspect, the cleaning off of the organic deposition material may be performed using a short wavelength laser beam.

According to a non-limiting aspect, the short wavelength laser beam may have a wavelength in a range from 200 nm to 500 nm.

According to a non-limiting aspect, the short wavelength laser beam may be irradiated substantially perpendicular to the surface of the mask facing the substrate.

According to a non-limiting aspect, the scan rate of the short wavelength laser beam may be determined such that the energy of the short wavelength laser beam reaches the organic deposition material more quickly than the energy reaches the mask.

According to a non-limiting aspect, the temperature of the organic deposition material to which the short wavelength laser beam is irradiated may be in a range from 600° C. to 1200° C.

According to a non-limiting aspect, the cleaning off of the organic deposition material may be performed by further disposing a blocking mask (having a pattern with a plurality of openings corresponding to the boundaries of the slots of the mask) in front of the mask.

According to a non-limiting aspect, the cleaning off of the organic deposition material may be performed using a line-type short wavelength laser beam simultaneously irradiated to the plurality of openings contained in the blocking mask.

According to a non-limiting aspect, the cleaning off of the organic deposition material may be performed using UV rays.

According to a non-limiting aspect, the cleaning off of the organic deposition material may be performed using plasma.

According to a non-limiting aspect, the forming of the organic deposition material pattern and the cleaning off of the organic deposition material may be performed at substantially the same degree of vacuum.

According to a non-limiting aspect, the degree of vacuum in the deposition chamber and the degree of vacuum in the stock chamber may be each maintained at about 10E-7 Torr or less.

According to another aspect of the present invention, there is provided a system to clean off an organic deposition material accumulated on a mask used to form an organic deposition material pattern on a substrate, wherein the mask has a plurality of slots, the system including: a deposition chamber including a deposition source; and a stock chamber that is maintained at substantially the same vacuum as the deposition chamber and includes a cleaning device that cleans off the organic deposition material accumulated on the mask.

According to a non-limiting aspect, the system may further include an opening and closing device between the deposition chamber and the stock chamber to isolate the deposition chamber and the stock chamber from each other.

According to a non-limiting aspect, the system may further include a transporting device to transport the mask between the deposition chamber and the stock chamber.

According to a non-limiting aspect, the transporting device may be configured to detach the mask from the substrate and transport the mask from the deposition chamber to the stock chamber.

According to a non-limiting aspect, the cleaning device may clean off the organic deposition material using plasma.

According to a non-limiting aspect, the cleaning device may clean the organic deposition material accumulated on the boundaries of the slots.

According to a non-limiting aspect, the cleaning device may use a short wavelength laser beam having a wavelength in a range from 200 nm to 500 nm.

According to a non-limiting aspect, the system may further include a blocking mask having a pattern with a plurality of openings corresponding to the boundaries of the slots of the mask, wherein the blocking mask is disposed between at least a portion of the cleaning device of the stock chamber and the mask.

According to a non-limiting aspect, the cleaning device may use a line-type short wavelength laser beam simultaneously irradiated to the plurality of openings contained in the blocking mask.

According to a non-limiting aspect, the cleaning device may use plasma.

According to a non-limiting aspect, the cleaning device may use UV rays.

According to a non-limiting aspect, the degree of vacuum in the deposition chamber and degree of vacuum in the stock chamber may be each at about 10E-7 Torr or less.

According to a non-limiting aspect, the temperature of the organic deposition material in the stock chamber may be in a range from 600° C. to 1200° C.

According to a non-limiting aspect, the cleaning device includes: a first electrode; a second electrode spaced apart from the first electrode; a power supply unit connected to the first electrode and the second electrode and configured to apply a voltage between the first electrode and the second electrode to form a plasma between the first electrode and the second electrode; and a support member disposed between the first electrode and the second electrode and supporting the mask. Here, the cleaning device is configured to remove an organic material deposited on the mask by using the plasma.

Additional aspects and/or advantages of the invention will be set forth in part in the description which follows and, in part, will be apparent from the description, or may be learned by practice of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

These and/or other aspects and advantages of the invention will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the accompanying drawings of which:

FIG. **1** is a flowchart illustrating a method of cleaning an organic deposition material accumulated on a mask used to deposit an organic pattern on a substrate;

FIG. **2** is a schematic view for describing deposition of an organic deposition material on a substrate for an OLED panel using a fine metal mask (FMM) in a deposition chamber;

FIG. **3** is a schematic view illustrating deposition of an organic deposition material on a substrate for an OLED panel using a first nozzle-type mask in a deposition chamber;

FIG. **4** is a perspective view of the deposition apparatus of FIG. **3**;

FIG. **5** is a schematic cross-sectional side view of the deposition apparatus of FIG. **4**;

FIG. **6** schematically illustrates the amount of an organic deposition material accumulated according to the position of a nozzle-type mask;

FIG. **7** is a schematic view illustrating an apparatus that irradiates a laser beam that scans an organic deposition material of a mask in a stock chamber;

FIG. **8** is a schematic view illustrating a laser beam scanning along the boundary of a slot;

FIG. **9** is a schematic view illustrating a blocking mask arranged in front of a nozzle-type mask;

FIG. **10** is a schematic view illustrating the scanning of a nozzle-type mask using a line-type laser beam with a blocking mask;

FIG. **11** is a schematic view illustrating deposition of an organic deposition material on a substrate for an OLED panel using a second nozzle-type mask in a deposition chamber;

FIG. **12** is a perspective view of the deposition apparatus of FIG. **11**; and

FIGS. **13** and **14** are schematic cross-sectional side views of the deposition apparatus of FIG. **12**.

FIG. **15** is a cross-sectional view illustrating a cleaning device for removing an organic material deposited on a mask by using plasma.

DETAILED DESCRIPTION

Reference will now be made in more detail to the present embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to the like elements throughout. The embodiments are described below in order to explain aspects of the present invention by referring to the figures.

FIG. **1** is a flowchart illustrating a method of cleaning an organic deposition material accumulated on a mask used to form an organic pattern on a substrate. As used herein, the term "cleaning" an organic deposition material accumulated on a mask typically refers to removing or cleaning off the accumulated organic deposition material from the mask.

Referring to FIG. **1**, before cleaning the organic deposition material accumulated on the surface of the mask used to form an organic deposition material pattern on the substrate, a mask including a plurality of slots is aligned on the substrate in a deposition chamber (operation a**1**), and a number of depositions of the organic deposition material on the substrate are performed (operation a**2**).

In this regard, the substrate may be a substrate for an organic light emitting device (OLED) panel. The substrate for the OLED panel includes organic thin film micro patterns for intermediate layers such as an emission layer, an electron injection layer, an electron transport layer, a hole transport layer, and a hole injection layer between an anode and a cathode. In order to form the organic thin film micro patterns by deposition, masks having patterns corresponding to the organic thin film micro patterns are prepared. The masks and the substrate for an OLED panel are aligned in a deposition chamber that is maintained at a high vacuum such that the pattern of the mask corresponds with the pattern to be formed on the substrate. The method according to the present embodiment is not only applicable to substrates for OLED panels, but also to any substrate on which organic thin film patterns are formed.

In the deposition chamber, organic deposition material that has been vaporized in a deposition source passes through the mask onto the substrate, thereby forming an organic pattern corresponding to the pattern of the mask. In the deposition process, a single mask may be used to deposit the organic deposition material on a plurality of substrates for a predetermined number of repetitions.

Meanwhile, while the deposition process is repeatedly performed, devices within the deposition chamber including the mask are subjected to preventive maintenance (PM) at a predetermined cycle. Since the deposition process is stopped while the PM is performed, and since it takes a long time to reach deposition conditions including the degree of vacuum required for the deposition process after the PM is terminated, a short PM cycle may decrease productivity.

In general, the PM cycle is determined according to the shortest cycle among PM cycles required for each of the elements in the deposition chamber. In particular, since the organic deposition materials are excessively accumulated on the mask during the deposition, and may consequently influence the formation of the organic thin film pattern, the mask needs to be cleaned at a relatively short predetermined cycle. The cleaning cycle of the cleaning of the mask influences the PM cycle.

Conventionally, the cleaning of the mask is performed while the PM is performed. A wet cleaning process using a chemical solvent generally used to clean a mask during a semiconductor process may not be used in the deposition chamber since the OLED display device is vulnerable to oxygen and moisture. Thus, a separate cleaning system is used outside of the deposition chamber.

Accordingly, the method of cleaning off organic deposition materials according to the present embodiment includes transporting a mask that has been used for a plurality of depositions to a stock chamber that is maintained at a high vacuum and that is adjacent to the deposition chamber, and cleaning the mask in the stock chamber (operation b).

In addition, the method of cleaning organic deposition materials according to the present embodiment includes locally cleaning the mask transported to the stock chamber by scanning the inclined surface of the mask pattern on which organic deposition material is accumulated (operation c).

Hereinafter, the method and system to clean off the organic deposition material accumulated on the mask used for the deposition of the organic deposition material pattern will be described in more detail referring to FIGS. **2** to **14**.

FIG. **2** is a schematic view to describe deposition of an organic deposition material on a substrate **160** for an OLED panel using a fine metal mask (FMM) **140** in a deposition chamber **10**.

Referring to FIG. **2**, a deposition of an organic deposition material on the substrate **160** for an OLED panel using an FMM **140** will be described in more detail.

The FMM **140** has the same size as the substrate **160** in order to have the same pattern as an organic thin film pattern to be formed on the substrate **160**. The FMM **140** is aligned on the substrate **160** in firm contact with the substrate **160**.

In this regard, the FMM **140** may have a striped shape. In the etching of the pattern of the FMM **140**, a plurality of first slots **141** that are substantially parallel to each other and extend in a predetermined direction are formed in the FMM **140**. Also, on a side of the FMM **140** opposite to that facing the substrate **160**, the surfaces of the boundaries **142** between the first slots **141** are formed to be oblique with respect to bases **143**. In other words, the first slots **141** are wider on the side of the FMM **140** opposite to the side that faces the substrate **160**, and the boundary surfaces **142** between the first slots **141** extend from the side of the FMM **140** that faces the substrate (at an angle between the side of the FMM **140** that faces the substrate **160** and the surface of the substrate) to the side of the FMM **140** opposite to the side that faces the substrate **160**. The side of the FMM **140** opposite to the side that faces the substrate **160** includes a base surface **143** between the first slots **141**.

A deposition source **110** disposed apart from the FMM **140** and the substrate **160** includes a crucible containing the organic deposition material to be deposited on the substrate **160**. The deposition source **110**, the FMM **140**, and the substrate **160** are disposed in the deposition chamber **10**. The deposition chamber **10** may be maintained at a high vacuum in order to allow the organic deposition material to move in a straight direction. The degree of vacuum in the deposition chamber **10** may be equal to or less than about 10E-7 Torr.

The organic deposition material is vaporized in the deposition source **110** and passes through the first slots **141** formed in the FMM **140** to be deposited on the substrate **160**. The organic deposition material pattern is formed on the substrate **160** while the deposition source **110** is moved relative to the FMM **140**. The organic deposition material vaporized in the deposition source **110** is deposited within a predetermined angle θ**1** with respect to the surface of the FMM **140**. The predetermined angle θ**1** is generally equal to or less than 55°.

The organic deposition material that has not passed through the first slots **141** accumulates on the bases **143** and the boundaries **142** of the first slots **141** of the FMM **140**.

FIG. **3** is a schematic view for describing deposition of an organic deposition material on a substrate **160** for an OLED panel using a first nozzle-type mask **150** in a deposition chamber **10**. FIG. **4** is a perspective view of the deposition apparatus of FIG. **3**. FIG. **5** is a schematic cross-sectional side view of the deposition apparatus of FIG. **4**.

Referring to FIGS. **3** to **5**, a deposition of an organic deposition material on a substrate **160** for an OLED panel using the first nozzle-type mask **150** will be described in more detail.

The deposition using the first nozzle-type mask **150** is similar to that using the FMM **140** described above, in that the deposition using the first nozzle-type mask **150** also involves using a plurality of slots, referred herein as second slots **151**. However, the deposition using the first nozzle-type mask **150** is different from that using the FMM **140** for the following reasons.

One difference between using the FMM **140** and using the first nozzle-type mask **150** is that the sizes of the masks are different. In more detail, since the size of the FMM **140** is the same as the substrate **160**, the FMM **140** is aligned to correspond to the substrate **160**. By contrast, the deposition using the first nozzle-type mask **150** is performed while the first nozzle-type mask **150** is moved in the Z-axis direction within the deposition chamber **10**. In other words, when deposition is completed by the first nozzle-type mask **150** at a first position of the substrate, the first nozzle-type mask **150** is moved in the Z-axis direction by the length of the first nozzle-type mask **150** and performs the deposition at a second position of the substrate. Thus, the first nozzle-type mask **150** may be much smaller than the FMM **140**. That is, if the width of the first nozzle-type mask **150** in the Y-axis direction is the same as that of the substrate **160** in the Y-axis direction, the length of the first nozzle-type mask **150** in the Z-axis direction may be less than that of the substrate **160** in the Z-axis direction.

As described above, since the length of the first nozzle-type mask **150** may be far less than that of the FMM **140**, it may be more convenient to manipulate the first nozzle-type mask **150** in all processes including etching, precise extension, welding, moving, and cleaning processes. This is more advantageous for a relatively large display device.

Another difference between using the FMM **140** and using the first nozzle-type mask **150** is that positions of the deposition sources relative to the masks and degrees of incidence angles of the organic deposition materials vaporized in the deposition sources are different with respect to the first nozzle-type mask as compared to the FMM **140**. Referring to FIG. **2**, when using the FMM **140**, the deposition of the organic deposition material on the substrate **160** is performed by the FMM **140** while the deposition source **110** is moved relative to the FMM **140**. However, referring to FIGS. **3** to **5**, when using the first nozzle-type mask **150**, the position of the first nozzle-type mask **150** is fixed relative to the deposition source **110**. In addition, in the deposition using the FMM **140**, the organic deposition material vaporized in the deposition source **110** is discharged at an angle up to about 55° with respect to the FMM **140**. However, in the deposition using the first nozzle-type mask **150**, the organic deposition material is discharged at an angle θ**2** that is far less than that of the FMM **140**. That is, the organic deposition material vaporized in the deposition source **110** is discharged more perpendicularly to the first nozzle-type mask **150** than to the FMM **140**.

To control the deposition angle when using the first nozzle-type mask **150**, a barrier wall assembly **130** (including a plurality of barrier walls **131** that partition a space between the deposition source **110** and the first nozzle-type mask **150** into a plurality of sub-deposition spaces, each of which includes a first slit **121** through which the organic deposition material vaporized in the deposition source **110** is discharged) is disposed between the deposition source **110** and the first nozzle-type mask **150**. This will be described below in more detail.

In order to deposit an organic deposition material **115** that is discharged from the deposition source **110** through the first slits **121** and the second slots **151**, onto the substrate **160** in a desired pattern, the deposition chamber **10** should be maintained in a high-vacuum state as in a deposition method using the FMM **140**. In order to maintain a high vacuum state, the temperatures of the barrier walls **131** and the first nozzle-type mask **150** should be sufficiently lower than the temperature of the deposition source **110**. In this regard, the temperatures of the barrier walls **131** and the first nozzle-type mask **150** may be about 100° C. or less. If the temperature of the barrier wall assembly **130** and the second slots **151** is sufficiently low, the deposition material **115** that is radiated in an undesired direction is adsorbed to the surface of the barrier wall assembly **130**, and a high vacuum state may be maintained. In a high vacuum state, a straight motion of the particles of the deposition material may be achieved because the collisions between the particles of the deposition material typically do not occur.

The deposition source **110** that contains and heats the deposition material **115** is disposed in an opposite side of the deposition chamber **10** to where the substrate **160** is disposed. As the deposition material **115** contained in the deposition source **110** is vaporized, the deposition material **115** is deposited on the substrate **160**. The deposition source **110** includes a crucible **111** that is filled with the deposition material **115**, and a heater **112** that heats the crucible **111** to vaporize the deposition material **115**, which is contained in the crucible **111** such that the vaporized deposition material is directed toward a side of the crucible **111**, and in particular, towards the first slit **121**.

The plurality of first slits **121** are disposed at a side of the deposition source **110**, and in particular, at the side of the deposition source **110** facing the substrate **160**. In this regard, the first slits **121** may be arranged at equal intervals in the Y-axis direction. The deposition material **115** vaporized in the deposition source **110** passes through the first slits **121** toward the substrate **160**.

The barrier wall assembly **130** is disposed between the first slits **121** and the first nozzle-type mask **150**. The barrier wall assembly **130** includes the plurality of barrier walls **131** and a barrier wall frame **132** that covers sides of the barrier walls **131**. The plurality of the barrier walls **131** may be arranged parallel to each other at equal intervals in the Y-axis direction. In addition, each of the barrier walls **131** may be formed to extend along an XZ plane in FIG. **4**, i.e., perpendicular to the Y-axis direction. As described above, since the space between the deposition source **110** and the first nozzle-type mask **150** is partitioned by the barrier walls **131**, the deposition material **115** discharged through one of the first slits **121** is not mixed with the deposition material **115** discharged through the other first slits **121**, and is deposited on the substrate **160** through the second slots **151**.

The barrier wall frame **132** may surround the plurality of barrier walls **131**. The barrier wall frame **132**, which covers upper and lower sides of the barrier walls **131**, retains the positions of the barrier walls **131**, and guides the deposition material **115**, which is discharged through the first slits **121**, not to deviate in a Z-axis direction.

In addition, the barrier wall assembly **130** may be constructed to be detachable from the first nozzle-type mask **150**. Thus, deposition efficiency may be increased compared to the FMM deposition method. As used herein, the term "deposition efficiency" refers to the ratio of an amount of a deposition material deposited on a substrate to an amount of the deposition material vaporized from a deposition source. The FMM deposition method has a deposition efficiency of about 32%. In other words, in the conventional FMM deposition method, about 68% of organic deposition material, which has not been deposited on the substrate, remains adhered to the inside of the deposition apparatus, such that it is not practical to reuse the deposition material. However, in the deposition method using the first nozzle-type mask **150**, the deposition space is enclosed by using the barrier wall assembly **130**, so that the deposition material that is not deposited on the substrate **160** is mostly deposited within the barrier wall assembly **130**. Thus, when a large amount of the deposition material accumulates in the barrier wall assembly **130** after a long deposition process, the barrier wall assembly **130** may be detached from a thin film deposition apparatus, and then placed in a separate deposition material recycling apparatus to recover the deposition material. Due to this structure according to the present embodiment, a reuse rate of the deposition material is increased, so that the deposition efficiency is improved and manufacturing costs are reduced.

Although the barrier wall assembly **130** is in close contact with the first nozzle-type mask **150** according to the present embodiment, the present invention is not limited thereto. The barrier wall assembly **130** may be disposed to be separated from the first nozzle-type mask **150** by a predetermined distance to precisely align the first nozzle-type mask **150** and the substrate **160**.

The organic deposition material (that has not passed through the second slots **151** of the first nozzle-type mask **150**) accumulates on bases **153** and boundaries **152** of the second slots **151** of the first nozzle-type mask **150**.

Another difference between using the FMM **140** and using the first nozzle-type mask **150** is that distances between the masks and the substrates are different. In the deposition method using the FMM **140**, deposition is performed with the FMM **140** in close contact with the substrate **160** in order to prevent the formation of a shadow zone on the substrate **160**. However, when the FMM **140** is used in close contact with the substrate **160**, the contact may cause defects. Accordingly, in the deposition method using the first nozzle-type mask **150**, the first nozzle-type mask **150** is spaced apart from the substrate **160** by a predetermined distance (Λ). As described above, the size of the shadow zone formed on the substrate may be reduced by installing the barrier walls **131** between the deposition source **110** and the first nozzle-type mask **150**. As a result, defects caused due to the contact between the substrate **160** and the first nozzle-type mask **150** may be prevented. Furthermore, since it is unnecessary to use the first nozzle-type mask **150** in close contact with the substrate **160** during a deposition process, the manufacturing speed may be improved. Since the first nozzle-type mask **150** may be separated from the substrate **160** and transported to a stock chamber **20** (see FIGS. **7** and **8**), it is straightforward to clean the first nozzle-type mask **150** in the stock chamber **20**.

FIG. **6** schematically illustrates the amount of an organic deposition material OM that may accumulate according to the position of a nozzle-type mask.

In FIG. **6**, the vertical axis represents a distance x from the center of the first nozzle-type mask **150**, and the horizontal axis represents a thickness d of the organic deposition material OM accumulated on the first nozzle-type mask **150**.

The organic deposition material OM that is vaporized from the deposition source **110**, but has not passed through the second slots **151** of the first nozzle-type mask **150**, is accumulated on the bases **153** and the boundaries **152** of the first nozzle-type mask **150**. The thickness of the organic deposition material OM accumulated on the boundaries **152** is about 20% of the thickness of the organic deposition material OM accumulated on the bases **153**. That is, the amount of the organic deposition material OM accumulated on the boundaries **152** is lower than that accumulated on the bases **153**. This result may be observed in the deposition using the FMM **140**. In the deposition using the FMM **140**, the organic deposition material vaporized in the deposition source **110** is discharged at an angle of about 55° or less with respect to the FMM **140**. However, in the deposition using the first nozzle-type mask **150**, the organic deposition material is discharged at an angle θ**2** that is far less than that using the FMM **140**. Thus, the rate at which the organic deposition material is accumulated on the boundaries **152** of the first nozzle-type mask **150** is slower than the rate at which the organic deposition material is accumulated on the boundaries **142** of the FMM **140**.

Of the organic deposition material OM accumulated on the first nozzle-type mask **150**, the organic deposition material OM accumulated on the boundaries **152** of the second slots **151**, rather than the organic deposition material OM accumulated on the bases **153** of the first nozzle-type mask **150**, directly influences the size of the organic deposition material pattern formed on the substrate **160**. Thus, if the organic deposition material OM accumulated on the boundaries **152** of the second slots **151** is periodically removed during the deposition process, the number of PM cycles may be significantly reduced.

FIG. **11** is a schematic view illustrating deposition of an organic deposition material on a substrate for an OLED panel using a second nozzle-type mask in a deposition chamber. FIG. **12** is a perspective view of the deposition apparatus of FIG. **11**. FIGS. **13** and **14** are schematic cross-sectional side views of the deposition apparatus of FIG. **12**.

Referring to FIGS. **12** to **14**, a deposition of an organic deposition material on a substrate **260** for an OLED panel using a second nozzle-type mask **250** will be described and compared to the deposition using the FMM **140** and the deposition using the first nozzle-type mask **150** described above.

The deposition using the second nozzle-type mask **250** is similar to that using the FMM **140** and the first nozzle-type mask **150** described above, in that the deposition using the second nozzle-type mask **250** also involves using a plurality of slots, referred to herein as third slots **251**.

In addition, the size of the second nozzle-type mask **250**, like the first nozzle-type mask **150**, may be less than that of the FMM **140**. Specifically, the deposition is consecutively performed while the substrate **260** is moved in a direction (Y-axis direction). In other words, when deposition is completed by the second nozzle-type mask **250** at a current position, the substrate **260** is moved in the Y-axis direction by the length of the second nozzle-type mask **250** and the deposition is performed at the new position. Thus, the size of the second nozzle-type mask **250** may be far less than that of the FMM

140. That is, if the width of the second nozzle-type mask **250** in the X-axis direction is the same as that of the substrate **260** in the X-axis direction, the length of the second nozzle-type mask **250** in the Y-axis direction may be less than that of the substrate **260** in the Y-axis direction.

In addition, like the first nozzle-type mask **150**, the position of the second nozzle-type mask **250** is fixed relative to a deposition source **210**. However, even though the deposition source **210** is fixed, and the substrate **260** is moved according to FIGS. **12** to **14**, the present invention is not limited thereto. The substrate **260** may be fixed, and the deposition source **210** may be moved.

In the apparatus used with the first nozzle-type mask **150**, a plurality of barrier walls **131** that partition a space between the deposition source **110** and the first nozzle-type mask **150** into a plurality of sub-deposition spaces are disposed between the deposition source **110** and the first nozzle-type mask **150**, and the barrier wall frame **132** that guides the deposition material discharged though the first slits **121** not to deviate in a Z-axis direction, is disposed. However, in the apparatus used with the second nozzle-type mask **250**, a barrier wall is not disposed between the deposition source **210** and the second nozzle-type mask **250**. Instead, only a connection member **235** that corresponds to the barrier wall frame **132** is disposed. Although the second nozzle-type mask **250** is formed in the left and right directions to guide the deposition material along the X-axis direction according to FIGS. **12** to **14** for descriptive convenience, the connection member **235** may be formed in a sealed box shape to simultaneously guide the deposition material in both directions of the X-axis and Y-axis directions. Thus, since there is no need to form the barrier walls, the configuration of the deposition apparatus may be simplified compared to the deposition apparatus using the first nozzle-type mask **150**, and thus the deposition apparatus may be precisely controlled.

In addition, the second nozzle-type mask **250**, like the first nozzle-type mask **150**, is spaced apart from the substrate **260** by a predetermined distance (Λ'). In this regard, even though the barrier walls that are used for the first nozzle-type mask **150** are not disposed for the second nozzle-type mask **250**, nozzle-type second slits **221** are disposed at a side of the deposition source **210** facing the substrate **260** in the Y-axis direction, i.e., along the scanning direction of the substrate **260**, and the substrate **260** is moved in the Y-axis direction. Thus, the size of the pattern formed by the deposition material that passes through the third slots **251** of the second nozzle-type mask **250** is only influenced by the size of one nozzle-type second slit **221**, and therefore a shadow may be reduced.

In addition, since the plurality of second slits **221** are arranged in the scanning direction, the difference of the deposition amount between the individual second slits **221** may be offset while deposition is performed in the scanning direction to obtain uniform deposition. As a result, defects caused due to the contact between the substrate **260** and the second nozzle-type mask **250** may be prevented. Furthermore, since it is unnecessary to use the second nozzle-type mask **250** in close contact with the substrate **260** during a deposition process, the manufacturing speed may be improved. Since the second nozzle-type mask **250** may be separated from the substrate **260** and transported to a stock chamber **20**, it is straightforward to clean the second nozzle-type mask **250** in the stock chamber **20**.

Organic deposition material that has not passed through the third slots **251** of the second nozzle-type mask **250** accumulates on bases **253** and boundaries **252** of the second nozzle-type mask **250**.

As described above, in masks including a plurality of slots such as the FMM **140** including the first slots **141**, the first nozzle-type mask **150** including the second slots **151**, and the second nozzle-type mask **250** including the third slots **251**, the masks need to be cleaned periodically to remove the organic deposition material that is accumulated on the boundaries of the slots.

FIG. **7** is a schematic view illustrating an apparatus **210** that irradiates a laser beam that scans the organic deposition material OM of the first nozzle-type mask **150** in a stock chamber **20**. FIG. **8** is a schematic view illustrating a laser beam scanning along the boundary of a slot.

Referring to FIGS. **7** and **8**, the first nozzle-type mask **150** is disposed in the stock chamber **20**. Meanwhile, although the first nozzle-type mask **150** is shown in FIGS. **7** and **8**, aspects of the present invention may also be applied to the cleaning of other masks including a plurality of slots such as the FMM **140** and the second nozzle-type mask **250** which are described above. In this regard, the stock chamber **20** refers to a location in which the first nozzle-type mask **150** is stored, but is not limited thereto.

The stock chamber **20**, constituting a component of a deposition apparatus, is maintained at a high vacuum, as is the deposition chamber **10**. The degree of vacuum in the deposition chamber **10** may be substantially the same as that in the stock chamber **20**, and may be less than 10E-7 Torr. Although not shown in FIGS. **7** and **8**, the deposition chamber **10** may be disposed close to the stock chamber **20** or disposed apart from the stock chamber **20** as long as the degree of vacuum is maintained.

A transporting device (not shown) that transports the first nozzle-type mask **150** used in the deposition chamber **10** to the stock chamber **20** to clean the first nozzle-type mask **150** and transports the cleaned first nozzle-type mask **150** back to the deposition chamber **10**, may further be disposed between the deposition chamber **10** and the stock chamber **20**.

In addition, an opening and closing device (not shown) may further be disposed between the deposition chamber **10** and the stock chamber **20**. Without an opening and closing device, the deposition material vaporized from the deposition source in the deposition chamber **10** may flow into the stock chamber **20**. Thus, the stock chamber **20** may be isolated from the deposition chamber **10** by the use (or means) of the opening and closing device while the mask cleaning process is performed in the stock chamber **20**.

The apparatus **210** that irradiates a short wavelength laser beam disposed in the stock chamber **20** constitutes a mask cleaning device. As a non-limiting example, the apparatus **210** that irradiates a short wavelength laser beam may irradiate a laser beam with a wavelength in a range from 200 nm to 500 nm, which efficiently removes the organic deposition material. A laser beam generating device (not shown) may further be disposed in the stock chamber **20**. A scanning device (not shown) that moves and controls the position of the apparatus **210** that irradiates a short wavelength laser beam may also be disposed in the stock chamber **20** such that the laser beam is irradiated to the target to be cleaned, i.e., the boundaries **152** of the second slots **151** of the first nozzle-type mask **150**.

As described above, since the first nozzle-type mask **150** is spaced apart from the substrate **160** in the deposition chamber **10** by a predetermined distance (Λ), the first nozzle-type mask **150** may be transported by itself from the deposition chamber **10**. The organic deposition material OM is locally cleaned while the apparatus **210** that irradiates a short wavelength laser beam scans the boundaries **152** of the second slots **151** of the first nozzle-type mask **150** that is transported into the stock chamber **20**.

The apparatus **210** that irradiates a short wavelength laser beam may irradiate a spot-type laser beam L to the front or rear surface of the first nozzle-type mask **150** on the boundaries **152** of the second slots **151** of the first nozzle-type mask **150**. In this regard, it is desirable to avoid irradiating the spot-type laser beam L inside the boundaries **152** of the first nozzle-type mask **150**, i.e., to a side of the bases **153** because direct irradiation of the spot-type laser beam L to the bases **153** may cause thermal expansion of the first nozzle-type mask **150**, thereby causing distortion of the first nozzle-type mask **150**. If a spot-type laser beam L with a short wavelength is irradiated on the boundaries **152** of the first nozzle-type mask **150**, the thermal energy of the spot-type laser beam L is transmitted to the organic deposition material OM accumulated on the boundaries **152** and then to the boundaries **152** of the first nozzle-type mask **150**. The scan rate of the laser beam L may be determined such that the energy of the spot-type laser beam L reaches the organic deposition material OM accumulated on the boundaries **152** more quickly than the boundaries **152** of the first nozzle-type mask **150**. Otherwise, the first nozzle-type mask **150** may be distorted by the thermal expansion of the boundaries **152** of the first nozzle-type mask **150**. In this regard, the temperature of the organic deposition material OM accumulated on the boundaries **152** of the first nozzle-type mask **150**, which is increased by the thermal energy, may be in a range from about 600° C. to about 1200° C. so that the organic deposition material OM may be sublimated at a pressure of about 10E-7 Torr or less.

The method of cleaning the boundaries **152** of the second slots **151** of the first nozzle-type mask **150** using the spot type laser beam L may also be applied to the deposition using the FMM **140**.

A line-type short wavelength laser beam L' may also be used in the mask cleaning device when a blocking mask is used, as shown in FIGS. **9** and **10**. In particular, FIG. **9** is a schematic view illustrating a blocking mask **170** arranged in front of the first nozzle-type mask **150**, and FIG. **10** is a schematic view illustrating the scanning of the first nozzle-type mask **150** using a line-type laser beam with a blocking mask **170**.

The spot type laser beam L described with reference to FIGS. **7** and **8** may be directly irradiated on the boundaries **152** of the second slots **151** of the first nozzle-type mask **150** by controlling pulses, but it takes a long time to scan the entire area of the boundaries **152** of the second slots **151**. On the other hand, the line-type short wavelength laser beam L' has a predetermined length so as to be simultaneously (or currently) irradiated on a plurality of boundaries **152** of the second slots **151**. However, since the line-type short wavelength laser beam L' may also be irradiated on the bases **153** of the first nozzle-type mask **150**, the temperature of the first nozzle-type mask **150** may increase. Thus, a blocking mask **170** is disposed between the first nozzle-type mask **150** and the line-type short wavelength laser beam L'.

The blocking mask **170** has a slit pattern **171** with openings corresponding to boundaries **152** of the second slots **151** of the first nozzle-type mask **150**. The blocking mask **170** may be prepared by deposing a metal layer on a soda lime glass.

The blocking mask **170** having the slit pattern **171** is disposed in front of the first nozzle-type mask **150** such that the slit pattern **171** aligns with the boundaries **152** of the second slots **151** of the first nozzle-type mask **150**. The line-type short wavelength laser beam L' is irradiated to the first nozzle-type mask **150** with the blocking mask **170** disposed in front of the first nozzle-type mask **150**.

The line-type short wavelength laser beam L' passes through the plurality of slit patterns **171** formed in the blocking mask **170** to reach the plurality of boundaries **152** of the second slots **151** of the first nozzle-type mask **150**. That is, since the line-type short wavelength laser beam L' is irradiated not on the bases **153** of the first nozzle-type mask **150**, but on the boundaries **152** of the second slots **151**, the organic deposition material accumulated only on the boundaries **152** of the second slots **151** of the first nozzle-type mask **150** may be cleaned while the increase in the temperature of the first nozzle-type mask **150** is prevented.

The line-type short wavelength laser beam L' may have a variety of line widths. If the width of the line-type short wavelength laser beam L' is the same as that of the first nozzle-type mask **150**, the cleaning time may be reduced by scanning the first nozzle-type mask **150** in the lengthwise direction, i.e., in the Z-axis direction, of the second slots **151** of the first nozzle-type mask **150**.

The mask cleaning device may use UV rays or plasma in addition to the line-type short wavelength laser beam L'. The line-type short wavelength laser beam L' may be efficiently used to partially clean the organic deposition material OM on the boundaries **152** of the second slots **151**. However, cleaning efficiency may be increased using UV rays or plasma, since the entire first nozzle-type mask **150** may be cleaned, and a plurality of the nozzle-type masks **150** may be cleaned in the stock chamber **20**.

The mask cleaning device using UV rays or plasma may also be used to partially clean the mask. However, it is not easy to locally irradiate the UV rays or plasma to the boundaries **152** of the second slots **151** of the first nozzle-type mask **150**. Thus, the blocking mask **170** that blocks the bases **153** of the first nozzle-type mask **150** may also be disposed between the first nozzle-type mask **150** and the UV rays or plasma. Since the UV rays and plasma may be irradiated to the entire first nozzle-type mask **150**, the cleaning time may be reduced compared to using the spot-type laser beam L or the line-type short wavelength laser beam L'.

As described above, according to aspects of the present invention, since the organic deposition material accumulated on the mask may be cleaned in the stock chamber while the deposition process is performed, there is no need to stop the deposition process and perform a separate PM in order to clean the mask. Thus, the PM cycle of the entire deposition process may be extended.

In addition, when a partial cleaning process is performed along boundaries of the second slits of the mask which strongly affect the formation of the pattern instead of cleaning the entire mask, the cleaning cycle of the mask may be extended.

Although a few embodiments of the present invention have been shown and described, it would be appreciated by those skilled in the art that changes may be made in this embodiment without departing from the principles and spirit of the invention, the scope of which is defined in the claims and their equivalents.

FIG. **15** is a cross-sectional view illustrating a cleaning device **300** for removing an organic material deposited on a mask by using plasma.

Referring to FIG. **15**, the cleaning device **300** includes a first electrode **310**, a second electrode **320**, a power supply unit **330**, and a support member **340**. The cleaning device **300** forms a plasma between the first electrode **310** and the second electrode **320**, and removes a material deposited on a mask **150** by using the plasma.

The first electrode **310** and the second electrode **320** are spaced apart from each other. The power supply unit **330** is connected to the first electrode **310** and the second electrode **320**, and applies a voltage between the first electrode **310** and the second electrode **320**. In one embodiment, there is a voltage difference between the first electrode **310** and the second electrode **320**.

The support member **340** is disposed between the first electrode **310** and the second electrode **320**. The support member **340** maintains an interval between the mask **150** and the first electrode **310** and an interval between the mask **150** and the second electrode **320** by supporting the mask **150** between the first electrode **310** and the second electrode **320**. The interval between the mask **150** and the first electrode **310** may be in a range from about 0.2 mm to about 0.4 mm.

The support member **340** may be formed of an insulating material. In one embodiment, since the support member **340** is formed of the insulating material, discharge is prevented from occurring in other portions than a place under a bottom surface of the mask **150**.

The mask **150** is disposed on the support member **340** to be located between the first electrode **310** and the second electrode **320**, and a material deposited on a surface of the mask **150** is removed by using plasma p formed by the voltage difference between the first electrode **310** and the second electrode **320**. In more detail, ions, radicals, and the like generated due to the plasma p cause physical and chemical reactions with an organic material deposited on the surface of the mask **150**, thereby removing the organic material.

A conventional cleaning method of cleaning a mask by using a cleaning solution has a problem in that the cleaning solution directly contacts a mask, thereby deforming the mask and changing pixel position accuracy (PPA). Also, the conventional cleaning method causes environmental pollution after use of the cleaning solution and increases processing costs in order to process the waste cleaning solution.

However, in one embodiment, since the cleaning device **300** of FIG. **15** does not use a cleaning solution, the deformation of the mask **150** is reduced, and environmental pollution after use of the cleaning solution and processing costs is also reduced. Further, since the cleaning unit **300** may clean the entire mask **150**, a processing time may be reduced, thereby improving productivity.

While the present invention has been described in connection with certain exemplary embodiments, it is to be understood that the invention is not limited to the disclosed embodiments, but, on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims, and equivalents thereof.

What is claimed is:

1. A method of cleaning off an organic deposition material accumulated on a mask used to form an organic deposition material pattern on a substrate, the method comprising:

using the mask, having a plurality of slots in a deposition chamber comprising a deposition source, to form the organic deposition material pattern on the substrate while the mask or the substrate is separated from the other by a set distance and moved relative to the other;

transporting the mask to a stock chamber maintained at a vacuum and adjacent to the deposition chamber;

cleaning off the organic deposition material accumulated on the mask in the stock chamber by using a cleaning device;

wherein the cleaning off of the organic deposition material is performed using plasma;

wherein the cleaning device comprises:

a first electrode;

a second electrode spaced apart from the first electrode;

a power supply unit connected to the first electrode and the second electrode and configured to apply a voltage between the first electrode and the second electrode to form the plasma between the first electrode and the second electrode; and

a support member disposed between the first electrode and the second electrode and supporting the mask during the cleaning off of the organic deposition material, and

wherein the cleaning device is configured to remove an organic material deposited on the mask by using the plasma.

2. The method of claim **1**, wherein boundaries of the slots are inclined.

3. The method of claim **1**, wherein the slots are disposed to be substantially parallel to each other and extend in a predetermined direction.

4. The method of claim **1**, wherein the substrate on which the organic deposition material pattern is formed comprises an organic light emitting device (OLED) panel substrate.

5. The method of claim **4**, wherein at least one organic deposition material selected from the group consisting of organic deposition materials used to form an emission layer, an electron injection layer, an electron transport layer, a hole injection layer, and a hole transport layer is deposited on the OLED panel substrate.

6. The method of claim **1**, wherein the organic deposition material pattern is formed by disposing the mask in close contact with the substrate, and depositing the organic deposition material on the substrate while the deposition source is moved relative to the mask.

7. The method of claim **1**, wherein the organic deposition material pattern is formed while the mask is spaced apart from the substrate by a predetermined distance, and wherein the organic deposition material is deposited on the substrate while the deposition source is fixed relative to the mask.

8. The method of claim **7**, wherein: a plurality of first slits are disposed along a first direction at one side of the deposition source, a plurality of barrier walls that partition a space between the deposition source and the mask into a plurality of sub-deposition spaces are disposed along the first direction, and a barrier wall assembly comprising a barrier wall frame that surrounds the barrier walls is disposed between the deposition source and the mask; and wherein the barrier wall assembly and the mask are detachable.

9. The method of claim **8**, wherein the plurality of slots formed in the mask provide a portion of the organic deposition material pattern to be formed on the substrate, and deposition of the organic deposition material on the substrate is conducted by scanning the mask along a direction perpendicular to the first direction with respect to the substrate.

10. The method of claim **7**, wherein a plurality of second slits are disposed along a first direction at one side of the deposition source, and a connection member that guides the deposition material which is discharged from the deposition source to the substrate is disposed between the deposition source and the mask; and wherein the connection member and the mask are detachable.

11. The method of claim **10**, wherein the plurality of slots formed in the mask provide a portion of the organic deposition material pattern to be formed on the substrate, and deposition of the organic deposition material on the substrate is conducted by scanning the substrate along the first direction with respect to the mask.

12. The method of claim **1**, wherein the cleaning off of the organic deposition material is performed by further disposing a blocking mask having a pattern with a plurality of openings corresponding to the boundaries of the slots of the mask in front of the mask.

13. The method of claim **1**, wherein the forming of the organic deposition material pattern and the cleaning off of the organic deposition material are performed at substantially the same degree of vacuum.

14. The method of claim **13**, wherein the degree of vacuum in the deposition chamber and the degree of vacuum in the stock chamber are each maintained at about 10E-7 Torr or less.

15. The method of claim **13**, wherein the mask is maintained in a vacuum when the mask is transported from the deposition chamber to the stock chamber.

16. The method of claim **1**, further comprising transporting the mask from the stock chamber to the deposition chamber after the organic deposition material accumulated on the mask has been cleaned off.

17. The method of claim **16**, wherein the mask is maintained in a vacuum when the mask is transported from the stock chamber to the deposition chamber.

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